DEPARTMENT OF ECONOMICS
UNIVERSITY OF CYPRUS

INDIRECT TAX REFORMS AND PUBLIC GOODS UNDER IMPERFECT COMPETITION

Ourania Karakosta and Nikos Tsakiris

Discussion Paper 2009-06

P.O. Box 20537, 1678 Nicosia, CYPRUS Tel.: ++357-2-892430, Fax: ++357-2-892432
Web site: http://www.econ.ucy.ac.cy

Indirect Tax Reforms and Public Goods under Imperfect Competition

Ourania Karakosta[a] and Nikos Tsakiris[b]

October 2009

Abstract

This paper examines, within an imperfectly competitive environment with public goods, the welfare effects of three popular indirect tax reforms: i) a tariff cut combined with an equal increase in the consumption tax, ii) a tariff cut combined with an increase in the consumption tax that leaves consumer price unchanged, and iii) an export tax reduction combined with an equal increase in the production tax. It is shown that the welfare effects of these reforms are ambiguous, in that they depend on the strength of the consumers' valuation of the public goods. This result contrasts existing results in the literature that ignores public goods provision.

Keywords: Tariff Reform; Tax Reform; Imperfect Competition; Public goods
JEL Classification: F12; F13; H20; H21

Acknowledgments: We thank Christos Kotsogiannis, Leo Michelis, and Panos Hatzipanayotou for comments and advice. The usual disclaimer applies.

[a] Department of Economics, University of Cyprus, P.O. Box 20537, Nicosia, CY 1678, Cyprus.
[b] Department of Economics, University of Ioannina, 45 110, Ioannina, Greece

Correspondence: Ourania Karakosta, Department of Economics, University of Cyprus, P.O. Box 20537, CY 1678, Nicosia, Cyprus. Tel. (+357) 22892397, Fax. (+357) 22892432, email: *karakosta.ourania@ucy.ac.cy*

1. Introduction

The welfare and revenue effects of indirect tax reforms have received considerable attention by both academics and policy advisors.[1] The main result of the theoretical literature in a perfectly competitive environment has been that reductions in tariffs (export taxes) combined with increases in consumption taxes (production taxes) improve welfare and government revenues (see, among others, Hatzipanayotou et al. 1994, Keen and Ligthart 2002, and Emran 2005). The reason for this is intuitive: A reduction in the tariff and an increase in consumption tax that keeps consumer price unchanged results in a more efficient allocation of resources, thereby improving welfare. Similarly, an export and production tax reform that keeps producer price unchanged improves consumption efficiency, by reducing excessive consumption of the exportable goods. The increase in revenues stems from a reduction in (implicit) production and consumption subsidies, respectively.

More recently, attention has turned to imperfectly competitive markets. Keen and Ligthart (2005), henceforth KL, analyse two reform policies under imperfect competition. The first one is a tariff reduction with one-for-one increase in consumption taxes, whereas the second one is a tariff reduction with a point-by-point consumption tax increases that leaves consumer prices unchanged. They show that unilateral coordinated tariff-tax reforms of the above type unambiguously reduce national welfare. The intuition behind this result is that a reduction in the import tariff that is combined with an increase in the consumption tax shifts rents from the imperfectly competitive domestic firm to the foreign firm. As a consequence, a tariff-tax reform that leaves consumer price unchanged decreases national welfare, since the adverse impact on domestic profits would more than offset increases in government revenue.[2]

Intermediate goods have also received some attention. Mujumdar (2004) considers an imperfectly competitive market with tradable intermediate goods and examines the welfare effects of a reduction of an import tariff on an intermediate input that is combined with a change in the profit tax. In this framework, tariff reductions in intermediate goods have favorable effects on the domestic firm's profits

[1] Such reforms are widely used in the structural adjustment and stabilization programs of the IMF and World Bank. See, for example, Rajaram (1994), and IMF (2005).

[2] A tariff reduction combined with a one-for-one increase in the consumption tax reduces national welfare as well. In this case, except for the adverse rent shifting effect there is another negative effect on national welfare through the reduction of the consumer's surplus.

and consumer surplus. More specifically, if the industry is a monopoly the government can rely on profit taxation to make up any shortfall in tariff revenue, while ensuring higher welfare for both consumers and producers. This result occurs because the larger the number of firms in the industry, the smaller is the increase in the industry's profit following the tariff reduction. Haque and Mukherjee (2005) show that if products are differentiated then the government could use the profit tax to make up any shortfall in tariff revenue, for any finite numbers of firms in the industry.

More recently, Abe and Naito (2008) have extended the analysis of KL by accounting for imported intermediate goods, and examine the welfare and revenue effects of tariff and consumption tax reform policies when tariffs apply not only to the final goods but also to the intermediate goods. They show that, under plausible conditions, reform policies that reduce the total tax burden on the intermediate good, while either leaving the total tax burden on the final good unchanged or changing the total tax burden on the final good so as to keep government revenue neutral, increase national welfare.

Though the aforementioned contributions are insightful, their insights may not apply to a more general framework where government revenues, instead of being returned as a lump-sum fashion to the consumers, are used to finance the provision of public goods. And this is precisely the objective of this paper. In particular, this paper askes: Do the welfare reducing effects of unilateral indirect tax reforms hold if the revenues are used to provide for a local public good that confers utility to the consumers?[3]

More specifically, this paper examines the welfare implications of indirect tax reforms, in the context of an international duopoly with a domestic and a foreign firm, when the entire tax revenue is used to finance the provision of a public good. In this framework, the home country's structure of indirect taxes consists of domestic taxes (consumption and production taxes), and trade taxes (imports tariffs and export taxes) and considers three types of indirect tax reforms: i) a tariff cut combined with an equal increase in the consumption tax, ii) a tariff cut combined with an increase in the consumption tax so as to leave the consumer price unchanged, and iii) an export tax

[3] Public goods under imperfect competition have not been neglected in the literature. See, for instance, Neary (1994) who considers the asymmetries between private and social cost of funds in the context of strategic trade and industrial policy. A similar approach is taken by Keen and Lahiri (1998), Kotsogiannis and Lopez-Garcia (2007) and Haufler and Pflüger (2007), in the context of the comparison between destination and origin principles, tax harmonization and commodity tax competition, respectively.

cut combined with an equal increase in the production tax. It is shown that these trade and tax reforms can be welfare improving, if the consumers' valuation for the public good is sufficiently high to offset any welfare loss arising from the reduction of consumer surplus and the domestic firm's profits.

The structure of the paper is the following. Section 2 describes the model. Section 3 examines the welfare effects of the three coordinated trade-tax reforms, while Section 4 summarizes and provides some concluding remarks.

2. The model

The model is that of KL, appropriately extended to incorporate a local public good and an additional policy reform of export and production taxes.

The world consists of two countries, called ''home'' and ''foreign'', and two tradable commodities. The first commodity is produced under conditions of constant returns to scale and perfect competition. This good is assumed to be untaxed by both countries, and is taken to be the numeraire (with its price being normalized to 1). The other good is a homogeneous good and is produced by two imperfectly competitive firms, one in each country. X (Y^*) denotes the quantity produced by the home (foreign) firm for domestic consumption, and Y (X^*) denotes the home (foreign) firm's exports. Aggregate consumption in the home market is, thus, $X + X^*$, and aggregate consumption in the foreign market is $Y + Y^*$. It is assumed that the two firms have identical linear cost structures, with, in particular strictly positive fixed cost, denoted by F, and strictly positive marginal cost c. There are no transportation costs.

The home country has four policy instruments at its disposal: i) a specific consumption tax, denoted by t, levied on domestic and foreign goods sold in the home country, ii) a tariff, denoted by τ, levied on home country imported goods, iii) a specific production tax, denoted by s, levied on the domestic sales of the home country firm and its exports to the foreign country, and iv) an export tax, denoted by ε, levied on home exported goods.[4]

Domestic and foreign country firm profits, denoted by Π and Π^* are, respectively, given by

[4] In the analysis that follows, it is assumed that the government does not use all the available policy instruments simultaneously.

$$\Pi = \left[q\left(X + X^*\right) - s - t - c \right] X + \left[q^*\left(Y + Y^*\right) - s - \varepsilon - c \right] Y - F, \quad (1)$$

$$\Pi^* = \left[q^*(Y + Y^*) - c \right] Y^* + \left[q(X + X^*) - t - \tau - c \right] X^* - F, \quad (2)$$

where $q\left(X + X^*\right)$ and $q^*\left(Y + Y^*\right)$ denote the inverse demand functions for the home and foreign country, respectively. Necessary conditions for profit maximization are given by

$$\Pi_X = q'X + q - s - t - c = 0, \quad \Pi^*_{X^*} = q'X^* + q - t - \tau - c = 0, \quad (3)$$

$$\Pi_Y = q^{*\prime}Y + q^* - s - \varepsilon - c = 0, \quad \Pi^*_{Y^*} = q^{*\prime}Y^* + q^* - c = 0, \quad (4)$$

where $q' < 0$ and $q^{*\prime} < 0$ are the derivatives of $q\left(X + X^*\right)$ and $q^*\left(Y + Y^*\right)$, respectively. Perturbation of (3) and (4) gives the effects of changes in domestic and trade taxes on the supply of X, X^*, Y^*, Y (the details of this are related in the Appendix), and in particular

$$dX = \frac{1}{3q'}(dt - d\tau + 2ds), \quad dX^* = \frac{1}{3q'}(dt + 2d\tau - ds) \quad (5)$$

$$dY = \frac{2}{3q^{*\prime}}(ds + d\varepsilon), \quad dY^* = \frac{1}{3q^{*\prime}}(-ds - d\varepsilon). \quad (6)$$

The two equations in (5) state that, other things being equal, a higher consumption tax rate, i.e., $dt > 0$, reduces both the domestic sales of the home country firm and exports of the foreign country to the home one by the same amount, while a decrease in the import tariff, i.e., $d\tau < 0$, increases exports of the foreign country firm, at the rate $dX^*/d\tau = 2/3q'$, and reduces the home country production sold in the home country at the rate $dX/d\tau = -1/3q'$. The implication of the latter result is that a lower τ increases total consumption, $X + X^*$, in the home country. Additionally, a higher production tax, i.e., $ds > 0$, reduces domestic production sold in the home country market at the rate $dX/ds = 2/3q'$, and increases foreign exports at the rate $dX^*/ds = -1/3q'$.

The two equations in (6) state that a higher production tax i.e., $ds > 0$ reduces home country exports, and increases foreign country production sold in the foreign country market. Lastly, a decrease in the export tax i.e., $d\varepsilon < 0$ increases home exports and decreases foreign production sold in the foreign market.

The government in the home country uses all its revenues to finance a publicly provided good, denoted by g, the unit price of which is equal to one. With consumption tax revenue $t(X + X^*)$, production tax revenue $s(X + Y)$, tariff revenue τX^* and export tax revenue εY, the quantity of the public good is given by

$$g = t(X + X^*) + s(X + Y) + \tau X^* + \varepsilon Y . \tag{7}$$

Home consumers derive utility $\Phi(g)$ from the public good, $\nu(q)$ from the private good and Π from domestic profits. Overall, then, the utility or welfare of consumer is given by[5]

$$W = \nu(q) + \Pi + \Phi(g), \tag{8}$$

with

$$dW = \nu'(q)\,dq + d\Pi + \Phi_g dg , \tag{9}$$

where $\Phi_g > 0 > \Phi_{gg}$. Equation (9) is central in the analysis that follows.

Notice that the indirect utility from the private good is equal to $\nu(q) = u\big(D(q)\big) - qD(q)$,[6] which is the consumer's surplus, and after making use of the fact that $u'\big(D(q)\big) = q$ and the market clearing condition $D = X + X^*$ yields

$$\nu'(q)\,dq = -(X + X^*)dq . \tag{10}$$

[5] It is worth noticing that this specification departs from issues of cross-ownership of the home consumers owning (all or part of) the foreign firm.

[6] $D(q)$ denotes the domestic demand for the (homogeneous) good.

3. Indirect Tax Reforms and Welfare

This section considers how the three coordinated trade and tax reforms affect the welfare of an imperfectly competitive economy when tax revenues, are used to finance the provision of a public good.

The first two cases examine only tariff-tax reforms by assuming that export and production taxes are zero, i.e., $\varepsilon = 0$, $s = 0$. The first reform considers a tariff cut combined with an equal increase in the consumption tax (i.e., $dt = -d\tau$), whereas the second examines a tariff cut combined with an increase in the consumption tax so as to leave the consumer price unchanged (i.e., $dt \neq -d\tau$ and $dq = 0$).[7] Finally, the last reform considers an export tax reduction combined with an equal increase in the production tax.

3.1 A tariff cut combined with an equal increase in the consumption tax.

Suppose that the policy reform is of equal but opposite magnitude in the consumption tax and import tariff in the sense that $dt = -d\tau$ **.** In this case equation (5) becomes

$$dX = -2dX^* = \frac{2}{3q'}dt\,, \tag{11}$$

implying[8] a reduction in the sales of the home country firm by $2/3q'$ and an increase the sales of the foreign firm (in the home country) by $-1/3q'$. Perturbing $q = q\left(X + X^*\right)$ and making use of (5) it is the case that

$$dq = q'dX + q'dX^* = (1/3)dt\,, \tag{12}$$

and so the consumer price is increased. Substituting now (12) into (10) one obtains

$$v'\left(q\right)dq = -(X + X^*)(1/3)dt < 0\,. \tag{13}$$

Equation (13) shows that this reform affects welfare negatively by reducing consumer surplus. It also reduces the home country firm's profits due to adverse rent shifting

[7] Though in a perfectly competitive environment these two policy reforms are equivalent under imperfect competition they are not.

[8] Notice that since the consumption tax and import tariff are levied on domestic and foreign goods sold in the home country i.e., $X + X^*$, the sales in the foreign country i.e., $Y + Y^*$ are not affected.

i.e., $d\Pi = (4/3q')(q-t-c)dt < 0$, since it increases imports and reduces sales of the domestic firm. Finally, perturbing equation (7) and setting $dt = -d\tau$, yields $dg = (-1/3q')\left[3(q-t-c)+\tau-t\right]dt$. Hence, this tariff-tax reform increases government revenue unambiguously if $\tau > t$; that is if the tariff rate is initially higher than the consumption tax.

Substituting (the differentials of) (1) and (7), the equations (11)-(13) and $dt = -d\tau$ in equation (9), and after some straightforward manipulations, one obtains

$$dW = -\frac{1}{3q'}\left[(\Phi_g - 1)(3\Delta + 4\tau) - 3\Delta - \tau - \Phi_g t\right]dt, \qquad (14)$$

where $\Delta \equiv (q-t-\tau-c) > 0$.[9] Close inspection of equation (14) shows that this type of indirect tax reform may *increase* or *decrease* the home country's welfare. Clearly, such ambiguity arises from the presence of the public good. If, for instance, Φ_g is sufficiently greater than unity (arguably the most likely case)[10] and $\tau > t$ (at the initial equilibrium), then this policy reform will be welfare increasing. In particular setting $dW = 0$, there is a threshold value of $\hat{\Phi}_g = (6\Delta + 5\tau)/(3\Delta + 4\tau - t)$ above which welfare increases (where $\hat{\Phi}_g > 1$). If, on the other hand, $\Phi_g = 1$ which is equivalent to a lump sum redistribution of tax revenues in the existing literature, then this reform decreases welfare. The latter case reconfirms the result in KL, but it does so in an economy with public goods. Summarizing the above discussion:

Proposition 1. *In the presence of public goods, the welfare implications of a small tariff cut combined with an opposite change in the consumption tax (of the same absolute magnitude) are ambiguous. The welfare effect will be positive if i) the consumer's valuation of the public good is sufficiently strong in the sense that* $\Phi_g > \hat{\Phi}_g$*, and ii) the tariff rate is initially higher than the consumption tax,* $\tau > t$.

[9] We assume that both firms are active in the initial equilibrium, for which, following (2), it is required that $q - t - \tau - c > 0$.

[10] Keen and Lahiri (1998), and Lahiri and Nasim (2005) offer empirical evidence for the value of Φ_g that is higher than unity.

Proposition 1 clearly shows that, interestingly, the effect of this policy reform on welfare is, in general, ambiguous[11] when tariff and tax revenues are used to finance the public good. This is in contrast to the case where government revenues are returned to the consumers as a lump sum transfer.

3.2 A tariff cut combined with an increase in the consumption tax so as to leave the consumer price unchanged.

Following this reform, it is the case that $dq = q'dX + q'dX^* = 0$, which implies, after using (5) that $d\tau = -2dt$. Making use, then, of equation (5) one obtains

$$dX = -dX^* = \frac{1}{q'}dt. \tag{15}$$

Equation (15) simply says that a tariff-tax reform policy that leaves the consumer price unchanged decreases the sales of the domestic firm in the home country by $1/q'$ and increases the foreign country sales in the home country by the same amount. Therefore total consumption in the home country remains unchanged.

Substituting the differentials of (1), (7), equations (10) and (15), and $d\tau = -2dt$ into equation (9), the welfare effect of this policy reform is given by

$$dW = -\frac{2}{q'}\left[q'X^* + (\Phi_g - 1)\tau\right]dt. \tag{16}$$

Equation (16) shows that, in this case too, the welfare implications of this policy reform critically depend on the presence of the public good and are ambiguous in sign. Such ambiguity has a simple intuition. The tariff-tax reform affects the home country's welfare through the change in consumer surplus, profits, and public good provision. Since this reform holds the consumer price constant, the consumer surplus

[11] It is possible to construct numerical examples which show that this reform can lead to either welfare improvement or welfare reduction. For instance suppose the inverse demand function has the form $D = a - \beta q$. Then, for parameter values, $a = 10, \beta = 0.9, c = 4, \Phi_g = 1.3, \tau = 3, t = 1$ one finds $dW/dt < 0$, while for parameter values $a = 10, \beta = 0.9, c = 4, \Phi_g = 1.6, \tau = 3, t = 1$ one finds $dW/dt > 0$.

remains unchanged. The implication of this reform is to reduce the profits[12] of the home country firm and increase government revenues.[13] If revenues were returned in a lump sum fashion to the consumers (as in the contribution of KL), the adverse implication for the home country firm's profits would offset the gain from the increase in government revenues, and thus national welfare would be reduced. However, in the presence of public goods this is not the case, since revenues generate positive utility through public good consumption. It is, thus, the case that the welfare consequence of this reform depends, critically, on the consumer's valuation of the public good. In particular, there is a threshold value $\bar{\Phi}_g = -q'X$ above which welfare increases. Summarizing:

Proposition 2. *In the presence of public goods a tariff-tax reform that leaves consumer prices constant has ambiguous effects on national welfare. The welfare effect will be positive if the consumer's valuation of the public good is sufficiently high, in the sense that* $\Phi_g > \bar{\Phi}_g$.

Proposition 2 emphasizes that the desirability of a *tariff-tax reform that leaves consumer prices constant* depends on the use of government revenues. If, for instance, revenues are returned to consumers in a lump sum way (as in KL) then this reform is undesirable. But if consumers value the public good sufficiently,[14] then this reform is welfare enhancing.

3.3 An export tax reduction combined with an equal increase in the production tax. Attention now turns to a reform that reduces the export tax and increase the production tax by the same amount.[15] In this case it is assumed that both the

[12] The domestic firm's profits are reduced i.e., $d\Pi = -2Xdt < 0$.

[13] In the second case of reform policy government revenues also increases, without the extra assumption regarding the import tariff and consumption tax rates i.e., $dg = -(2\tau/q')dt > 0$.

[14] We provide two numerical examples to show that this tariff-tax reform can affect the welfare both ways. For instance suppose the inverse demand function has the form $D = a - \beta q$. Then, for parameter values: $a = 10, \beta = 1.5, c = 3, \Phi_g = 1.5, \tau = 1, t = 1$ one obtains $dW/dt > 0$, while for parameter values $a = 10, \beta = 1.5, c = 3, \Phi_g = 1.2, \tau = 1, t = 1$ one obtains $dW/dt < 0$.

[15] For this type of reform, in a perfectly competitive environment, see, among others, Keen and Ligthart (2002), and Emran (2005).

consumption tax and import tariff are zero i.e., $t = 0, \tau = 0$. Since, in this case, $ds = -d\varepsilon$ equations (5) and (6) become, respectively

$$dX = \frac{2}{3q'} ds, \quad dX^* = -\frac{1}{3q'} ds, \tag{17}$$

$$dY = 0, \; dY^* = 0. \tag{18}$$

Equation (17) simply states that this indirect tax reform reduces the sales of the domestic firm in the home country by $2/3q'$ and increases home country imports by $-1/3q'$. Additionally, equation (18) indicates that the home country exports and the sales of the foreign country firm in the foreign country remain unchanged. Intuitively, an export tax reduction is offset by an equal increase in the production tax and thus, home country exports are unaffected. However, an increase in the production tax, that applies not only to home country exports but also to the sales of the domestic firm in the home country, reduces the sales of the domestic firm in the home country and increases exports of the foreign country firm.

Using equations (17) and (18) in the differentials of inverse demand functions, one obtains

$$dq = q'dX + q'dX^* = (1/3)ds, \tag{19}$$

$$dq^* = q^{*\prime} dY + q^{*\prime} dY^* = 0, \tag{20}$$

which show that the indirect tax reform while increasing the consumer price in the home country, it does not affect the foreign country consumer price. Substituting equation (19) in equation (10), one obtains the effect of this reform on consumer surplus

$$v'(q)dq = -(X + X^*)(1/3)ds < 0. \tag{21}$$

Since an export and production tax reform increases the consumer price in the home country, it follows that it reduces the consumer surplus. The home firm's profits are

also reduced, i.e., $d\Pi = -(4/3)Xds < 0$, since the sales of the domestic firm in the home market are reduced, while the home firm's exports remain unchanged.
Perturbing equation (7), after using (17), (18) and setting $ds = -d\varepsilon$, gives

$$dg = Xds + sdX = -(1/3q')\left[3(q - s - c) - 2s\right]ds. \qquad (22)$$

Equation (22) shows that an export tax reduction combined with an equal increase in the production tax has an ambiguous effect on government revenue. The first term in the right-hand-side of (22) is the *direct effect* of the policy reform on government revenue: A higher production tax, at constant levels of sales of the domestic firm in the home country market, increases government revenue. The second term in the right-hand-side of (22) is the *indirect effect* of the same policy and captures a reduction in government revenue due to lower sales of the domestic firm in the home country market, resulting from a higher production tax.

Substituting the differentials of (1), (2), the equations (17)-(22), and $ds = -d\varepsilon$ in equation (9), and after some manipulations one obtains

$$dW = -\frac{1}{3q'}\left\{(\Phi_g - 1)\left[3(q - c - s) - 2s\right] - 3(q - c)\right\}ds. \qquad (23)$$

Equation (23) shows that the welfare implications of an export tax reduction combined with an equal increase in the production tax are ambiguous in sign, when the entire tax revenue is used to finance the provision of a public good. In particular, the second right-hand-side term in brackets is unambiguously negative, while the sign of the first right-hand-side term in brackets is ambiguous and depends on the impact of this reform on government revenue. If revenues were returned in a lump sum fashion to the consumers i.e., $\Phi_g = 1$, then equation (23) becomes $dW = \frac{(q - c)}{q'}ds < 0$, that is this reform decreases welfare. However, if the *net effect* on government revenue of this reform is unambiguously positive (i.e., the *direct* effect dominates the *indirect* effect) and the consumer's valuation of the public good is sufficiently large, then this reform increases national welfare. In particular, there is a

threshold value $\tilde{\Phi}_g = [6(q-c)-5s]/[3(q-c-s)-2s]$ above which welfare increases. Summarizing:

Proposition 3. *In the presence of public goods the welfare implications of an export tax reduction combined with an equal increase in the production tax are ambiguous. The welfare effect will be positive if i) the net effect of this policy reform on government revenue is positive (i.e.,* $dg/ds > 0$ in equation 22), *and ii) the consumer's valuation of the public good is sufficiently strong in the sense that* $\Phi_g > \tilde{\Phi}_g$.

The results of this paper highlight the importance of the role of public goods in the model. According to the existing literature, shifting from trade taxes to domestic consumption taxes would not be recommended in imperfectly competitive environments. However, the more realistic assumption of public good provision implies that this strategy can be welfare enhancing under plausible conditions. These results strengthen the arguments in favor of the implementation of such reforms in developing countries.

5. Concluding remarks

This paper has investigated the welfare implications of three types of unilateral indirect tax reforms, within an imperfectly competitive framework with public good. It has shown that if tax revenues are used to finance the provision of a public good, then the welfare effects are ambiguous in general. In particular, if the consumers' valuation of the public good is higher than specific thresholds then the policy reforms will be welfare improving; otherwise they will be welfare reducing as in the existing literature.

The recognition of the use of government revenues has important policy implications. Take, for instance, the trade-tax reforms implemented in many developing countries under structural adjustment and stabilization programs of the IMF and World Bank. Clearly, the lack of the expenditure side of the public revenues (as in the contribution of KL) may render these indirect tax reforms as welfare reducing. But with public goods, as shown in this paper, this might not be the case.

APPENDIX

Derivation of equation (5) in the main text.

Perturbing the system in (3) for an arbitrary change in import tariff and domestic taxes, after using $dq = q'dX + q'dX^*$ yields

$$\begin{pmatrix} 2q' & q' \\ q' & 2q' \end{pmatrix}\begin{pmatrix} dX \\ dX^* \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}dt + \begin{pmatrix} 0 \\ 1 \end{pmatrix}d\tau + \begin{pmatrix} 1 \\ 0 \end{pmatrix}ds\,. \tag{A1}$$

After simple manipulations one obtains

$$\begin{pmatrix} dX \\ dX^* \end{pmatrix} = \frac{1}{3q'}\begin{pmatrix} 1 & -1 & 2 \\ 1 & 2 & -1 \end{pmatrix}\begin{pmatrix} dt \\ d\tau \\ ds \end{pmatrix} \tag{A2}$$

Therefore,

$$dX = \frac{1}{3q'}\left(dt - d\tau + 2ds\right), \quad \text{and} \quad dX^* = \frac{1}{3q'}\left(dt + 2d\tau - ds\right).$$

Derivation of equation (6) in the main text.

Perturbing the system in (4) for an arbitrary change in export and production taxes, after using $dq^* = q^{*\prime}dY + q^{*\prime}dY^*$ one obtains:

$$\begin{pmatrix} 2q'^* & q'^* \\ q'^* & 2q'^* \end{pmatrix}\begin{pmatrix} dY \\ dY^* \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}ds + \begin{pmatrix} 1 \\ 0 \end{pmatrix}d\varepsilon \tag{A3}$$

After simple manipulations we have:

$$\begin{pmatrix} dY \\ dY^* \end{pmatrix} = \frac{1}{3q^{*\prime}}\begin{pmatrix} 2 & 2 \\ -1 & -1 \end{pmatrix}\begin{pmatrix} ds \\ d\varepsilon \end{pmatrix} \tag{A4}$$

Therefore,

$$dY = \frac{2}{3q^{*\prime}}\left(ds + d\varepsilon\right), \quad dY^* = \frac{1}{3q^{*\prime}}\left(-ds - d\varepsilon\right).$$

References

Haufler, A., Pflüger, M., 2007. International oligopoly and the taxation of commerce with revenue-constrained governments. Economica 74, 451-473.

Haque, M.E., Mukherjee, A., 2005. On the revenue implications of trade liberalization under imperfect competition. Economics Letters 88, 27-31.

Hatzipanayotou, P., Michael, M.S., Miller, S.M., 1994. Win-win indirect tax reform. Economics Letters 44, 147-151.

Emran, M.S., 2005. Revenue-increasing and welfare-enhancing reform of taxes on exports. *Journal of Development Economics* 77, 277-292.

IMF, 2005. Dealing with the revenue consequences of trade reform. Background Paper for Review of Fund Work on Trade. Washington DC: The IMF Fiscal Affairs Department.

Keen , M., Lahiri, S., 1998. The comparison between destination and origin principles under imperfect competition. Journal of International Economics 45, 323-350.

Keen, M., Ligthart, J.E., 2002. Coordinating tariff reduction and domestic tax reform. Journal of International Economics 56, 489-507.

Keen, M., Ligthart, J.E., 2005. Coordinating tariff reduction and domestic tax reform under imperfect competition. Review of International Economics 13 (2), 385–390.

Kotsogiannis, C., Lopez-Garcia M.A., 2007. Imperfect competition, indirect tax harmonization and public goods. International Tax and Public Finance 14, 135-149.

Lahiri, S., Nasim, A., 2005. Commercial Policy Reform in Pakistan: Opening up the Economy under Revenue Constraints. International Tax and Public Finance 12, 723-739.

Mujumdar, S., 2004. Revenue implications of trade liberalization under imperfect competition. Economics Letters 82, 83-89.

Naito, T., Abe, K., 2008. Welfare- and revenue-enhancing tariff and tax reform under imperfect competition. Journal of Public Economic Theory 10, 1085-1094.

Neary, J.P., 1994. Cost asymmetries in international subsidy games: Should governments help winners or losers? Journal of International Economics 37, 197-218.

Rajaram, A. 1994. Tariff and tax reform. Do World Bank recommendations integrate revenue and protection objectives? Economic Studies Quarterly 45, 321-338.